

5. Termination Area

The termination area provides a short distance for traffic to clear the work area and to return to the normal traffic lanes. It extends from the downstream end of the work area to the END CONSTRUCTION or END ROAD WORK sign. A downstream taper may be placed in the termination area.

For some work operations, such as single location utility or maintenance repair, it may not be necessary to display a sign as it will be obvious to drivers that they have passed the work area.

There are occasions where the termination area could include a transition. For example, if a taper were used to shift traffic into opposing lanes around the work area, then the termination area should have a taper to shift traffic back to its normal path. This taper would then be in the transition area for the opposing direction of traffic. It is advisable to use a buffer space between the tapers for opposing traffic, as shown in Figure 16 (page 70).

Avoid "gaps" in the traffic control that may falsely indicate to drivers that they have passed the work area. For example, if the work area includes intermittent activity throughout a 1-mile section, the drivers should be reminded periodically that they are still in the work area. The primary purpose of the guide sign ROAD CONSTRUCTION NEXT ___ MILES is to inform the drivers of the length of the work area. It should not be erected until work begins.

B. Planning for Traffic Control

During planning for work zones, one should strive for the greatest payoff in terms of safety and convenience at a cost commensurate with the hazards and problems involved. A properly installed traffic control zone will allow traffic to pass through or around a work zone safely. It requires time and effort for planning, installation, and maintenance. All employees involved with work-zone safety should be properly trained. These include design, traffic and construction engineers, inspectors, superintendents, and foremen.

All work-zone traffic-control planning centers around an analysis of the work activity and relating it to the provision of adequate safety and capacity. What is the likelihood of motorists failing to negotiate the work zone safely? What are the consequences of such action on pedestrians, workers, or other motorists?

Planning for traffic control through a construction zone may be more involved than for maintenance or utility zones because of the differences in traffic disruption and duration of the work. Although the requirement for safety in all zones is the same, planning for the three types of work operations will be discussed separately. The exposure of traffic to potential hazards is a function of the traffic volume and the length of time that the closure will be in effect. The goals common to all traffic control zones are:

- to minimize accidents and accident severity; and
- to minimize inconvenience and conflict as a result of the work. It should be recognized that these goals may at times be at odds.

1. Minimize Accidents

For all work zones, the first fundamental principle is that safety should have a high priority through all stages of all work. The following list is a set of guidelines that may be helpful in achieving this goal:

- Use traffic control devices that are visible and effective.
- Follow the standards in the MUTCD on the use and location of tapers and transitions. Avoid introducing severely reduced travel path geometrics at the approaches to or within the work area.
- Minimize fixed object hazards. For example, use lightweight channelizing devices and use crash cushions to protect barrier ends. Sand bags should be placed on the bottom of supports for various devices so that they do not become projectiles as a result of a collision.
- Minimize traffic conflicts with workers and equipment. Consider using a portable barrier.
- Provide night visibility with illumination, reflectorized devices, warning lights, and pavement markings. Consider floodlighting hazardous areas. However, care should be taken to insure that the floodlights are not aimed in a way that would adversely affect motorist's vision.

- Provide safe pedestrian walkways by separating pedestrians from vehicular traffic and work activities. Provide safe pedestrian and vehicular access across or through driveways.
- Store equipment and materials outside the clear recovery zone as defined in the Guide for Selecting, Locating, and Designing Traffic Barriers (List of References #3).
- Provide a buffer space between traffic and workers.
- Provide safe employee access to work, storage areas, businesses, residences, and within the work area. Provide a safe entrance and exit for work vehicles. This may require the use of temporary traffic signals, flaggers, or temporary portable barriers.
- Plan for the safety of workers on the project as required by safety and health regulations. (e.g., safety clothing, hardhats, etc.)
- Flags and flashing lights should be utilized on work vehicles exposed to traffic. To protect mobile and moving operations, shadow vehicles may be used and equipped with signs, flags, flashing lights, and/or crash cushions as appropriate.

2. Minimize Inconvenience

Work in or near traveled lanes often causes confusion and disruption of normal traffic. The traffic control plan should be aimed at reducing inconvenience and conflicts, as stated above. Traffic movement should be inhibited as little as practicable. Traffic control in work sites should be designed on the assumption that motorists will only reduce their speeds if they clearly perceive a need to do so. Reduced speed zoning should be avoided as much as practicable. Frequent and abrupt changes in geometrics, such as lane narrowing, dropped lanes, or main roadway transitions which require rapid maneuvers, should be avoided. Provisions should be made for the safe operation of work vehicles, particularly on high speed, high volume roadways. Construction time should be minimized to reduce exposure to potential hazards.

The following list is a set of guidelines that may be helpful in achieving this goal:

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- Close only those lanes that must be closed and reopen them as soon as practicable to maintain maximum roadway capacity.
 - Avoid severe speed reductions.
 - Avoid traffic delays that could cause backups.
 - Avoid scheduling work during peak hours and holidays.
 - Prepare an alternate route or plan in case of an accident or other emergency. If an alternate route is not feasible, be prepared to use signs, flaggers, and radio announcements to warn traffic of the backup and to explain the delay.
 - Reduce inconveniences for pedestrians and bicyclists by providing the shortest and safest path, safe clearances, and minimum grades, steps, and curbs.
 - Emergency organizations, such as police, fire, and ambulance services, should be notified prior to the start of work. This will allow them to adjust their routes and/or work schedules accordingly.
 - Emergency vehicles should have a high priority in passing through a work zone or using an alternate route.
 - Access to police and fire stations, fire hydrants, and hospitals should be maintained at all times.

3. Utility Work Zones

Utility work may be divided into three classifications: emergency, maintenance and new construction. The guidelines for traffic control listed here are for normal situations and additional protection should be provided when special complexities and hazards exist.

Emergency Work

- Can occur at any time of day or night;
- May be caused by storm damage;

- May involve disruptions of utility service to customers;
- Work operation usually involves a small crew and a work vehicle for a short period of time;
- The work vehicle should be equipped with a yellow flashing light, a limited number of portable signs and channelizing devices in good condition, and equipment for flaggers in the event they are needed; and
- The extent of traffic control may be less than longer-term construction or maintenance, yet the safety of pedestrians, motorists, and workers should be provided.

4. Maintenance and New Construction for Utilities

The public will not easily make a distinction between maintenance and new construction. Therefore the type of traffic control used should be adequate for the nature, location, and duration of work, type of roadway, traffic volume and speed, and potential hazard. When new construction or some maintenance activities are planned (as opposed to emergency activities), the following guidelines should be considered:

- In urban areas, consider avoiding the hours of peak traffic when scheduling work.
- Maintain street and road work areas for only as long as is necessary to safely move in, finish the work, remove all utility work signs, and move out.
- Take special care to clearly mark suitable boundaries for the work space with channelizing devices so pedestrians and drivers can see the work space. If any of the traveled lanes are closed, tapers shall be used as required by the MUTCD. If a shoulder is closed, a shoulder taper is suggested.
- Pedestrians should not be expected to walk on a path which is inferior to the previous path. Loose dirt, mud, broken concrete, or steep slopes may force

pedestrians to walk on the roadway rather than the sidewalk. Repairs (temporary or permanent) to damaged sidewalks should be made quickly. This may include bridging with steel plates or good quality wood supports.

- Any work which cannot be completed during the day and which impedes traffic or presents a hazard overnight may need additional attention. Reflectorized signs and channelizing devices are required by the MUTCD. Warning lights are optional but should be considered.
- Any member of the crew who serves as a flagger should be equipped with a red flag or a STOP-SLOW paddle, a reflective vest, and should be trained for proper flagging procedures.
- Work areas involving excavations on the roadway generally should not exceed the width of one traffic lane at a time. The work should be staged and, if needed, approved bridging should be utilized. This type of activity should be fully coordinated with the Traffic Engineering Division or Public Works Department office having jurisdiction over the street or highway.

5. Highway Maintenance Work Zones

Maintenance operations are needed to preserve, repair, and restore the streets and highways and include those activities performed on travel-way surfaces, shoulders, roadsides, drainage facilities, bridges, signs, markings, and signals.

These operations may be emergencies (as a result of storms or accidents) or planned activities. They may be stationary, mobile, or moving operations. The traffic control needed will vary according to the nature, location, and duration of work; type of roadway; speed of traffic and potential hazard.

6. Traffic Control Plans for Construction Projects

A formal Traffic Control Plan (TCP) is required to be included in the plans, specifications and estimates (PS&E) for all Federal-aid projects by Federal-Aid Highway Program Manual (List of References #4.) Other construction projects should also have a TCP. These plans may range in scope from a very detailed TCP designed solely for a specific project, to a reference to standard plans, a section of

the MUTCD, or a standard highway agency manual such as this Handbook. The degree of detail in the TCP will depend on the complexity of the project and on the interaction of traffic needs and construction activities.

Highway agency design and traffic engineers will develop the TCP and include it in the PS&E. The contractor can develop a TCP, but may use it only if it is equal to or better than the TCP in the plans, and if it is approved by the highway agency.

The following people and organizations are normally involved in the development of a TCP:

- Transportation officials from local, state, and federal levels, including design, traffic, and construction engineers;
- Police and fire officials at the state and local levels; and
- Utility companies.

Once the TCP has been developed and approved but before construction starts, others should be notified, as follows:

- Businesses in the area;
- Affected public groups, such as homeowners' organizations;
- School officials, so they can change bus schedules if necessary;
- Local government officials, including the Chamber of Commerce; and
- Tow truck services.

The following factors need to be considered for the TCP:

- Economic and community
 - commercial business districts,
 - residential locations,
 - recreation areas,
 - shopping centers,

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- railroad crossings,
 - rural areas, and
 - other work planned adjacent to or within the area of the project;
- Traffic
 - volumes,
 - peak hours including holiday, special event and recreation traffic,
 - pedestrian traffic,
 - bicycles,
 - large vehicles such as trucks and buses,
 - speed of traffic,
 - capacity of roadway,
 - traffic signal operation (effect on existing vehicle detectors); and
 - Seasonal changes and weather, including
 - maintaining traffic control during seasonal shutdowns,
 - loss of visibility and damage to devices during rain or snow,
 - temperature restrictions for some phases of construction, and
 - maintenance of traffic control devices (cleaning, cutting vegetation away from signs).

A 24-hour workday may be desirable as it allows the total number of working days to be decreased. Consideration should include:

- Neighborhood objection to nighttime noise;
- Higher cost, for labor and lighting;
- Higher percentage of drinking drivers at night; and
- Limited available commercial services, such as supply of ready-mix concrete or aggregate.

The controlled staging of construction should be considered, including:

- The location of work (on roadway, shoulders, or sidewalks);
- The number of lanes required for the work activity;
- Hours of a day during which a lane may be closed;
- Whether work may progress simultaneously in both directions of traffic;
- The length of the work area (controlled staging such as guardrail removal and immediate replacement);
- Minimize time of exposure to hazards such as drop-offs;
- Time involved, such as curing of pavement or bridge decks;
- Remove or shield the motorist from hazards created by the work activity within the recovery area such as boulders, drainage basins, pipe, headwalls, blunt ends of guardrail, and sign supports; and
- Delays during traffic control set-up and take-down time (preferably during low traffic volume periods).

Traffic control planning should consider the inclusion of unit pay items in the construction contract to cover the furnishing, application, installation, and maintenance of traffic control devices of acceptable quality to comply with the agency's specifications.

Materials developed for the TCP may include but are not limited to:

- Scaled drawings of the control zone;
- List of devices selected for installation;
- Special manpower needs, such as flaggers;

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- Copies of permits;
 - Phone numbers of officials to be contacted in an emergency;
 - Scaled drawings of construction stages, including detours; and
 - Schedules for times during the day when work is permitted or when certain lanes should remain open.

7. Speed Control for Detours, Transitions, & Median Crossovers

Studies have shown that reliance upon speed zone signing alone is not an effective method of reducing travel speeds in work zones. This should be recognized during the design of the project. The following are some guidelines for determining speed limits in detours, transitions, and median crossovers:

- Detours and crossovers should be designed for speeds equal to the existing speed limit if at all possible. Speed reductions should not be more than 10 mph below the limit of the entering roadway.
- Where a speed reduction greater than 10 mph is unavoidable, the transition to the lower limit should be made in steps of not more than 10 mph.
- Where severe speed reductions are necessary, police or flaggers may be used in addition to advance signing. The conditions requiring the reduced speed should be alleviated as soon as possible.

8. Transitional Areas from Construction Zones to Sections of Older Roadways

Transitional areas from construction zones to sections of older highways should be carefully designed and located so that the driver can adjust to the reduced standards or changed conditions. It should be recognized that these transitional areas may remain in place for a period of time until the adjacent section of roadway is improved. The following factors should be considered when designing, constructing, and operating these transitional areas:

- Provide adequate sight distance and geometrics consistent with the roadway having the higher design speed.
- If channelizing devices other than portable barriers are used, they should be lightweight or yielding.
- Sign supports should be yielding or breakaway. Pavement markings should be used to provide a well defined path.
- Transitional areas should be kept clear of unnecessary hazards.

9. Pavement Drop-offs

Highway agencies have varying opinions as to which depth of pavement drop-off needs some type of treatment. They also have varying opinions as to the type of treatment that should be used. A research project is underway that may provide guidance as to where and what type of devices to use for drop-offs of different depths with varying roadway conditions.

Drop-offs should be kept to a minimum in frequency, duration, and depth. When they are inevitable, good judgment should be used to determine the treatment that will be employed. The following items should be considered when developing a TCP for a project that will have pavement drop-off conditions:

- Where possible, the contract should limit the amount of difference in elevation between adjacent lanes.
- The time that a difference in elevation will be allowed should be limited.
- Signs can be used to advise motorists of the drop-off condition.
- A fillet or wedge of gravel or paving material can be placed as shown in Figure 7 (page 56).
- Where excessive drop-offs are necessary it may be possible to close the adjacent lane with appropriate channelizing devices. If the adjacent lane cannot be closed, it may be necessary to install longitudinal roadside barriers such as guardrail or portable concrete barrier.